Les ondes de choc extracorporelles dans le traitement de la spasticité

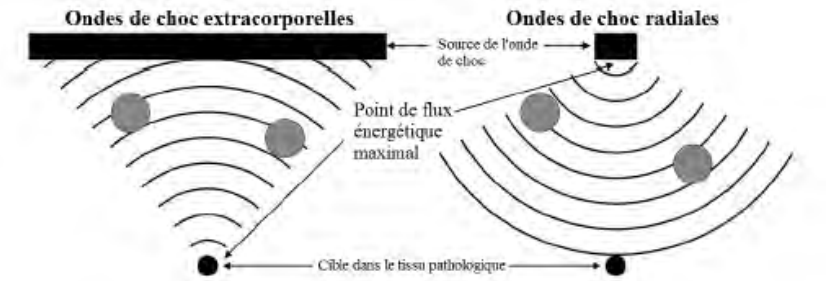
6ème Symposium Spasticité
CHU UCL Namur site Godinne
21 Octobre 2017

Prof. Th. Deltombe (Médecine Physique & Réadaptation)
Consultation interdisciplinaire de la spasticité

HISTORIQUE

- Ondes de Choc Extracorporelle (OCE) = Extracorporeal Shock Wave Therapy (ESWT)
- Traitement des tendinopathies
  - Wu Arch Phys Med Rehabil 2017
- Effets principaux OCE
  - antalgique par dispersion substance P
  - augmentation microcirculation ➔cicatrisation
  - dissolution fibroblastes calcifiés

Ondes de choc focale et radiale



Quid dans le traitement de la spasticité ?

ETUDE 1 : OCE – AVC – APRES BoNT-A

Santamato et al – SBOTE Study – Ultrasound in Med & Biol 2013

ETUDE 1 : OCE – AVC – APRES BoNT-A

Santamato et al – SBOTE Study – Ultrasound in Med & Biol 2013

- 

ETUDE 1 : OCE – AVC – APRES BoNT-A

Santamato et al – SBOTE Study – Ultrasound in Med & Biol 2013

- RCT : prospective vs electrostimulation
- Population : 32 hémiplégiques chroniques
- Intervention
  - groupe A : ona BoNT-A FDS (112 ± 23U) + ES (belly / 50-90 mA / 5Hz) 30min 2X/J pdt 5J VS
  - groupe B : ona BoNT-A FDS (118 ± 26U) + OCE focale (1000 I belly + 1000 I tendon / 0,030mJ/mm2 / 4 Hz) 1X/ J pdt 5J (group B)
- Evaluation : MAS, SFS « =spasms Penn score », VAS (douleur)
- Suivi : T0 – T2sem – T4sem – T12sem
-

OCE – AVC – APRES BoNT-A

Santamato et al – SBOTE Study
Ultrasound in Med & Biol 2013

- Effet sur spasticité & douleur

Gr B (OCE) > Gr A (ES)
- sur spasticité
- sur douleur
- persiste à 12 semaines

Table 3. Baseline and follow-up results for all outcome measures [MAS, SFS and VAS] in patients with post-stroke upper limb spasticity who received BTX-A with ES (group A) or BTX-A with ESWT (group B)

Time	Scale	Group A Mean ± SD	Group B Mean ± SD	*p* value
t_0	MAS	3.62 ± 0.5	3.5 ± 0.52	0.2722
	SFS	2.56 ± 1.03	2.37 ± 1.15	0.2828
	VAS	5.25 ± 1.34	5 ± 1.21	0.3013
t_1	MAS	2.37 ± 0.5	1.37 ± 0.5	0.0001*
t_2	MAS	2.18 ± 0.4	1.75 ± 0.45	0.0147*
	SFS	1.5 ± 0.82	0.81 ± 0.65	0.0033*
	VAS	2.44 ± 0.89	1.94 ± 0.68	0.0359*
t_3	MAS	2.18 ± 0.4	1.58 ± 0.52	0.0007*
	SFS	1.06 ± 0.77	0.25 ± 0.44	0.0014*
	VAS	2.69 ± 0.79	1.87 ± 0.62	0.0007*

BTX-A = botulinum toxin type A; ES = electrical stimulation; ESWT = extracorporeal shock wave therapy; SD = standard deviation; MAS = modified Ashworth scale; SFS = spasm frequency scale; VAS = visual analogue scale; t_0 = before treatment; t_1 = 15 days after treatment; t_2 = 30 days after treatment; t_3 = 90 days after treatment.
* Statistically significant.

OCE – AVC – APRES BoNT-A

Santamato et al – SBOTE Study - Ultrasound in Med & Biol 2013

- Conclusion
  - BoNT-A + ES & BoNT-A + OCE réduisent spasticité et douleur avant-bras
  - BoNT-A + ESWT > BoNT-A + ES
  - Mécanisme d'action inconnu
  - Lien entre spasticité et douleur ?

ETUDE 2 : OCE – AVC – AVANT-BRAS

Manganotti et al – Stroke 2005

- RCT prospective vs placebo (monocentrique)
- Population 20 hémiplégiques chroniques
- Intervention (1 session)
  - groupe OCE focale : fléchisseurs poignet - doigts (muscle / 1500 I / 0,030 mj/mm2) + interosseux (muscle / 3200 I / 0,030 mj/mm2) VS
  - groupe placebo (sham OCE)
- Evaluation : MAS, video + goniomètre digital, amplitude potentiel moteur (ADM) & EMG détection 1er IO à 4 sem
- Suivi : T0 – T1sem – T4sem – T12sem

9

OCE – AVC – AVANT-BRAS

Manganotti et al – Stroke 2005

- Spasticité (MAS)

OCE > placebo

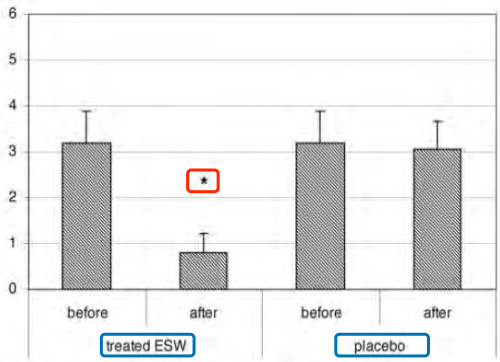


Figure 1. Ashworth scale of finger flexors before and after actual treatment. ESWT is shown on the left side, whereas placebo treatment is on the right. Mean and SD. $P<0.001$ with Bonferroni correction.

10

OCE – AVC – AVANT-BRAS

Manganotti et al – Stroke 2005

- Spasticité (MAS)

OCE efficace pdt 12 semaines

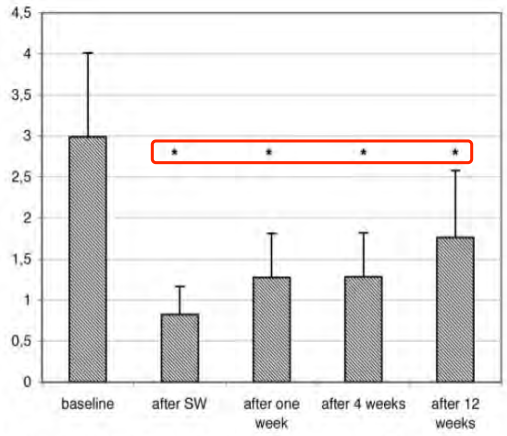


Figure 3. Ashworth scale for the finger flexors before and immediately after the ESWT and at 1, 4, and 12 weeks after the ESWT. Mean and SD. *P<0.001 with Bonferroni correction.

11

OCE – AVC – AVANT-BRAS

Manganotti et al – Stroke 2005

Efficacité fléchisseurs doigts > poignet

Clinical and Electrophysiological Findings

	Baseline	After Placebo	After ESWT	After 1 Week	After 4 Weeks	After 12 Weeks	P Value
Ashworth wrist flexors	3.4 (0.7)	3.3 (0.6)	2.0 (0.9)*	2.4 (0.6)*	2.3 (0.7)*	3.0 (0.5)	P<0.001
Ashworth finger flexors	3.2 (0.6)	3.06 (0.5)	0.8 (0.4)*	1.2 (0.4)*	1.3 (0.4)*	1.8 (0.7)*	P<0.001
Range of motion (°)	20 (7)	20 (6)	50 (6)*	50 (7)*	40 (6)*	30 (8)	P<0.001
Motor nerve conduction (ms)	55 (6)	54 (7)	57 (5)	54 (8)	55 (7)	56 (7)	NS
Latency CMAP (ms)	3.5 (1.3)	3.6 (2)	3.9 (1.7)	3.6 (1.4)	3.5 (2)	3.5 (3)	NS
Amplitude CMAP (mV)	11 (2)	12 (2)	11 (2)	12 (1.8)	11 (2.1)	11 (2)	NS
F Wave Mean Latency (ms)	25 (5)	25 (6)	23 (4)	23 (6)	25 (4)	26 (3)	NS
F Wave mean amplitude (uV)	700 (100)	790 (120)	650 (200)	670 (140)	680 (150)	700 (140)	NS

Values are expressed as mean and SDs.
*P<0.001 with Bonferroni correction.
CMAP indicates compound motor action potential.

12

OCE – AVC – AVANT-BRAS

Manganotti et al – Stroke 2005

- Conclusion
  - OCE ↘ spasticité fléchisseurs de doigts & poignet
  - pendant 12 semaines (fléchisseurs de doigts)
  - pas d'effet secondaire rapporté

ETUDE 3 : OCE – AVC – AVANT-BRAS

Li et al – Medicine 2016

- RCT : : prospective, simple-aveugle vs placebo
- Population : 60 hémiplégiques chroniques
- Intervention : OCE 1500I – 3,5bar – 5Hz FCU-FCR + 4000I – 3bar – 5Hz IO – FDS-FDP
  - Group A : 1 session OCE radial / semaine pdt 3 sem
  - Group B : 1session OCE radial
  - Group C : 1 session sham OCE / semaine pdt 3 sem (placebo)
- Evaluation : MAS + échelle Fugl-Meyer
- Suivi : T0 – T1sem – T4sem – T8sem - T12sem – T16sem

OCE – AVC – AVANT-BRAS

Li et al – Medicine 2016

- Effet <u>immédiat</u> sur spasticité fléchisseurs de poignet et de doigts

Gr A (3 sessions) > Gr B (1 session) > Gr C (3 session placebo) = 0

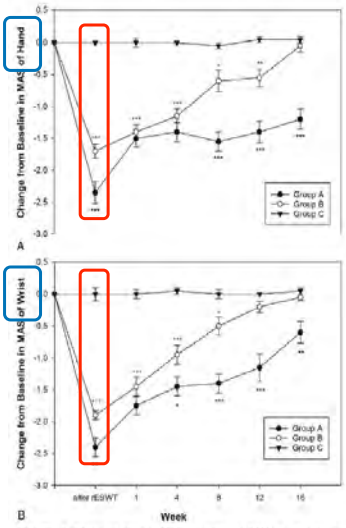


FIGURE 3. Mean of change from baseline in MAS in all groups (mean ± standard error). (A) MAS of hand: group B had significant improvement compared with group C until week 12. The differences between group A and group B reach significant at most of the observed time-points (except week 1 and week 4). (B) MAS of wrist: group B had significant improvement compared with group C until week 8. The differences between group A and group B reach significant at most of the observed time-points (except week 1). ($^{*}P < 0.05$, $^{**}P < 0.01$, and $^{***}P < 0.001$ mean group A vs B; $^{+}P < 0.05$, $^{++}P < 0.01$, and $^{+++}P < 0.001$ mean group B vs C. One-way ANOVA followed by the Bonferroni post hoc tests was used). ANOVA = analysis of variance, MAS = Modified Ashworth Scale.

OCE – AVC – AVANT-BRAS

Li et al – Medicine 2016

- Effet <u>à distance</u> sur spasticité fléchisseurs de poignet et de doigts

Gr A (3 sessions) > Gr B (1 session) > Gr C (3 session placebo) = 0

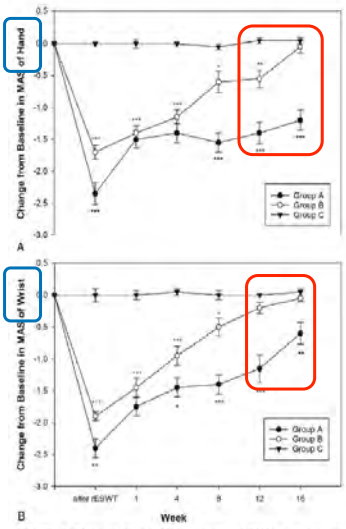


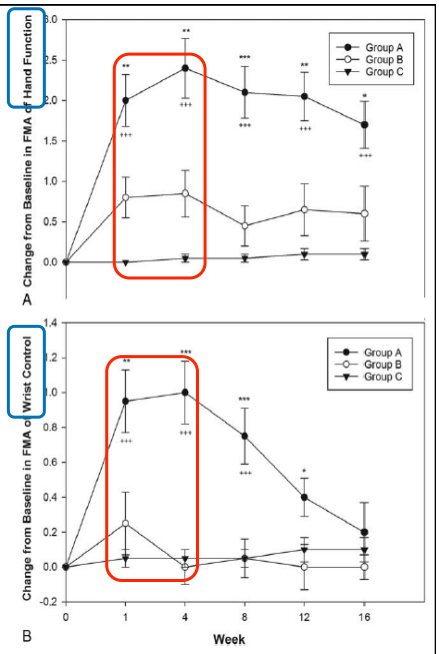
FIGURE 3. Mean of change from baseline in MAS in all groups (mean ± standard error). (A) MAS of hand: group B had significant improvement compared with group C until week 12. The differences between group A and group B reach significant at most of the observed time-points (except week 1 and week 4). (B) MAS of wrist: group B had significant improvement compared with group C until week 8. The differences between group A and group B reach significant at most of the observed time-points (except week 1). ($^{*}P < 0.05$, $^{**}P < 0.01$, and $^{***}P < 0.001$ mean group A vs B; $^{+}P < 0.05$, $^{++}P < 0.01$, and $^{+++}P < 0.001$ mean group B vs C. One-way ANOVA followed by the Bonferroni post hoc tests was used). ANOVA = analysis of variance, MAS = Modified Ashworth Scale.

OCE – AVC – AVANT-BRAS

Li et al – Medicine 2016

- Effet <u>immédiat</u> sur
  - fonction de la main
  - contrôle du poignet

Gr A (3 sessions) > Gr B (1 session) > Gr C (3 session placebo) = 0



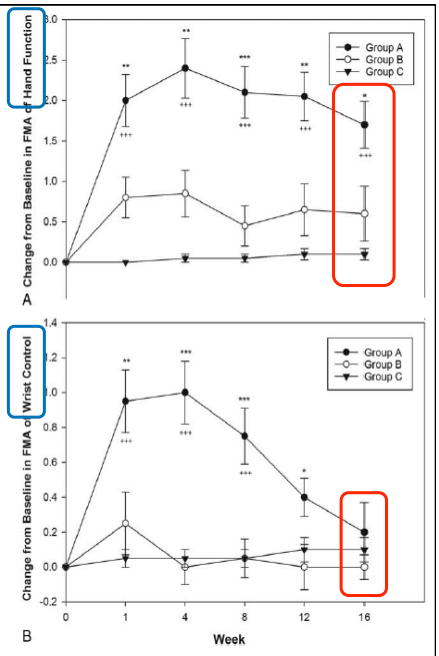
17

OCE – AVC – AVANT-BRAS

Li et al – Medicine 2016

- Effet <u>à distance</u> sur
  - fonction de la main

Gr A (3 sessions) > Gr B (1 session) > Gr C (3 session placebo) = 0



18

OCE – AVC – AVANT-BRAS

Li et al – Medicine 2016

- Conclusion
  - OCE
    - ↘ spasticité fléchisseurs de doigts & poignet
    - ↗ fonction main et contrôle poignet
  - 3 sessions vs 1 session apportent
    - effet supérieur sur spasticité et fonction
    - effet plus prolongé de 16 semaines vs 12 semaines
  - OCE radial > focal ? Pas clair !
  - Pas d'effets secondaires

19

ETUDE 4 : OCE – AVC – MOLLET

Moon et al – Ann Rehabil Med 2013

- RCT : : prospective vs placebo (cross-over)
- Population : 20 hémiplégiques chroniques
- Intervention
  - placebo (sham ESWT) + OCE focale medial & lateral gastrocnemius (musculotendinous junction / 1500 I / 4 Hz / 0,089 mj/mm2)
  - 3 sessions / 1X/semaine
- Evaluation
  - MAS, clonus scores (CS), passive ROM, Fugl Meyer
  - Isocinétique excentric torque à 60°, 180° & 240°
- Suivi : T0 – post sham – post OCE – T1sem – T4sem

20

OCE – AVC – MOLLET

Moon et al – Ann Rehabil Med 2013

- Spasticité (MAS)

OCE efficace
- 1 semaine
- pas à 4 semaines

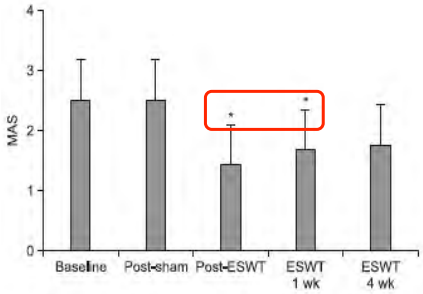


Fig. 3. Modified Ashworth Scale (MAS) of ankle plantar flexor before and after treatment. MAS was significantly improved immediately and 1 week after extracorporeal shock wave therapy (ESWT), but was not significantly changed at 4 weeks after ESWT. *Statistically significant compared with baseline ($p<0.05$).

OCE – AVC – MOLLET

Moon et al – Ann Rehabil Med 2013

- Torque excentrique

OCE réduit torque excentrique triceps

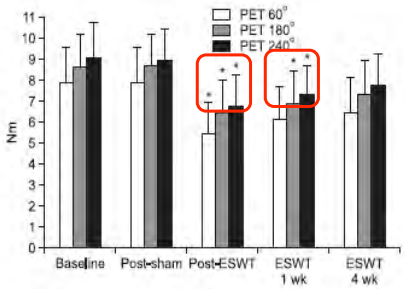


Fig. 4. Peak eccentric torque (PET) of ankle plantar flexor before extracorporeal shock wave therapy (ESWT) and after sham stimulation, and at immediately 1 week and 4 weeks after ESWT. *Statistically significant compared with baseline ($p<0.05$).

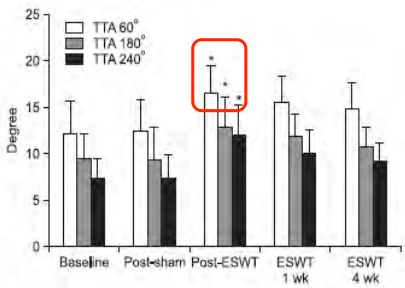


Fig. 5. Torque threshold angle (TTA) of ankle plantar flexor before extracorporeal shock wave therapy (ESWT) and after sham stimulation, and at immediately 1 week and 4 weeks after ESWT. *Statistically significant compared with baseline ($p<0.05$).

OCE – AVC – MOLLET

Moon et al – Ann Rehabil Med 2013

- Conclusion
  - OCE ↘ spasticité triceps sural
  - pendant 1 semaine (pas plus)
  - ↘ spasticité correlée à l'évaluation biomécanique (passive isokinetic torque & treshhold angle)

META-ANALYSE & REVIEW

Lee et al – J Phys Ther Sci 2014
Mori et al BioMed Research International 2014

OCE focal & radiale ↘ spasticité

Table 1. Studies that evaluated the effect of extracorporeal shock wave therapy

Year Published	Author	Population	Tested muscle	No. of patients	Follow-up (weeks)	Modified Ashworth Scale							
						Baseline		After ESWT		p-value	4 weeks after ESWT		p-value
						Mean	SD	Mean	SD		Mean	SD	
2013	Gonokova et al.	Cerebral palsy	Plantar flexor	25	4	2.70	0.09	2.00	0.08	0.001	2.15	0.07	0.001
2010	Amelio et al.	Cerebral palsy	Plantar flexor	12	12	3.30	0.49	1.80	0.38	0.001	2.25	0.45	0.001
2005	Manganotti et al.	Stroke	Wrist flexor	20	12	3.40	0.70	2.00	0.90	0.001	2.30	0.70	0.001
			Finger flexor	20	12	3.20	0.60	0.80	0.40	0.001	1.30	0.40	0.001
2013	Moon et al.	Stroke	Plantar flexor	30	4	2.50	0.67	1.41	0.67	0.002	1.75	0.62	0.019
2011	Sohn et al.	Stroke	Plantar flexor	10	-	2.67	1.15	1.22	1.03	0.035		-	

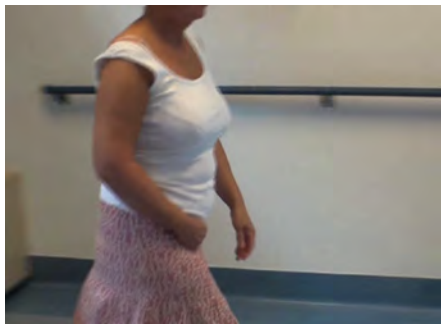
ESWT = extracorporeal shock wave therapy

OCE : MODE D'ACTION

- Incertain !
- Stimulation synthèse NO impliqué dans la formation de la jonction neuro-musculaire ?
- Ne semble pas lié à
  - ↘ excitabilité spinale vu absence de modifications ondes F & H
    - Sohn et al – Ann Rehabil Med 2011
  - dénervation vu absence de modification EMG
- Effet direct sur
  - composante non-reflexe de l'hypertonie
    - Mori et al BioMed Research Int 2014
  - destruction plaques motrices (modèle rat)
    - Kenmoku et al Muscle & Nerve 2017

25

Cas clinique / membre supérieur post-AVC

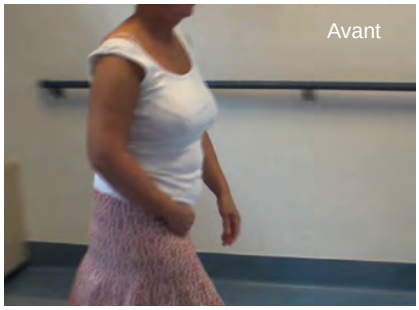


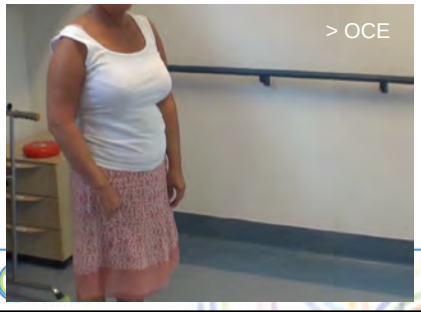
26

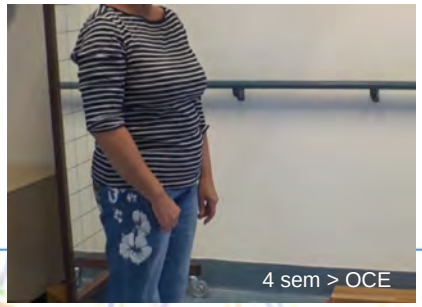
27

Fléchisseurs coude

Pré	A3T2 180/100/160
Immédiat	A2T2180/140160
4 semaines	A1 T2 180/150/170







28

Fléchisseurs de doigts

Pré	A3T2 180/60/40
Immédiat	A2T2180/120/40
4 semaines	A3 T2 180/90/40

29

TAKE HOME MESSAGE

- OCE ↘ la spasticité
  - seule ou en association avec BoNT-A
  - aux fléchisseurs de l'avant-bras et triceps sural
  - pendant 12 à 16 semaines
  - 3 sessions donnent effet + prolongé
- Muscle – 1500 I – 0,030 mj/mm2 approprié
- Bonne tolérance – pas d'effets secondaires

30

TAKE HOME MESSAGE

- Mécanisme d'action inconnu mais
  - ne semble pas lié à une diminution de l'excitabilité spinale
  - plutôt lié à un effet direct sur le muscle – plaque motrice
- OCE radiale et focale efficace

QUESTIONS SANS REPONSES

- Place des OCE dans le traitement de la spasticité focale (études comparatives)
  - pattern multiple avec dose maximale BoNT-A ?
  - effet insuffisant kiné + BoNT-A ?
- Indications – cibles – doses – fréquences optimales
- Effets thérapeutiques à long terme (études à long terme)
- Effets secondaires à long terme (études à long terme)

Merci pour votre attention

thierry.deltombe@uclouvain.be